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Circular No. 715

October 1944 • Washington, D. C.

UNITED STATES DEPARTMENT OF AGRICULTURE

Poultry-Breeding-Stock Selection For Desired Characters

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INTRODUCTION

The objective of the poultry breeder should be the development of a strain that will be acceptable to the purchaser. He must have chickens that are efficient producers of eggs and poultry meat and representative of the breed and variety. Such a project requires pedigreeing, trapnesting, and selecting for a large number of characters. If the strain is unsatisfactory in one or more characters of economic importance or if the birds are poor representatives of the breed and variety, the breeder is handicapped even if the strain is very outstanding in other characters.

CHARACTERS AFFECTING BREED IMPROVEMENT

The breeder may be interested in many characters, some of which will be outstanding in his particular breed or strain, but the characters that are most important from the standpoint of breed improvement are presented in the following outline.

I. Egg production.
  A. Number of eggs laid.
    1. Sexual maturity (beginning of production).
    2. Rate of production (intensity, or speed).
    3. Persistency (late molting or continuous production).
    4. Freedom from broodiness.
    5. Freedom from pause.

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I. Egg production—Continued.
  B. Quality of eggs laid.
    1. Weight.
    2. Shape.
    3. Color.
    4. Shell texture.
    5. Firmness of albumen.
    6. Freedom from blood and meat spots.

II. Viability.
  A. Hatchability (viability of embryo prior to hatching).
  B. Livability of growing stock.
  C. Laying-house livability.

III. Physical characters (those other than the reproduction functions and the ability to resist adverse environmental influences.)
  A. Breed type.
  B. Plumage color.
  C. Freedom from defects.
  D. Freedom from disqualifications.
  E. Rate of growth.
  F. Rate of feathering.
  G. Body weight.
  H. Quality as a meat bird at different ages (broiler, fryer, roaster, and fowl).

The breeder must pedigree and raise chicks from a large number of sires and dams if he makes maximum progress in selecting for a large number of these characters. Annual trapnesting of the daughters is also necessary to measure the rate of production and the characters that constitute quality of eggs laid.

INHERITANCE OF THE VARIOUS CHARACTERS

Each of the characters in the foregoing outline is not necessarily a genetic factor but may represent a number of factors inherited in various ways. Some are inherited only to a low degree and are greatly affected by environmental influences, whereas others are inherited to a high degree and are only slightly affected by environmental influences. Some of the genetic factors may be simple economic characters or a part of, or related to, these economic characters. They may be due to one or more dominant or recessive factors, each acting independently in its expresion, or they may be due to a combination of genes. The genes are transmitted from the parents to their progeny, but except with complete linkage the same combinations are not transmitted.

A desirable economic character may be a result of desirable genes acting to suppress the effect of undesirable genes or a result of the additive or cumulative and competitive effect of a number of desirable genes. Since very little is known concerning the inheritance of most of the economic characters, more emphasis should be placed on the sister and progeny records and less on the individual records.

The most desirable sires and dams are those whose progeny exhibit the best combination of all of the characters desired. The breeder must decide which individuals to select for parents on the basis of the relative importance of all the characters previously outlined. His

objective is to make the maximum genetic improvement in his flock as quickly as possible and with a minimum of effort.

TYPES OF SELECTION

Three types of selection are used by breeders. These are known as (1) the tandem, or one-character-at-a-time, method, (2) the total-score or index, method, and (3) the independent-culling method.

In using the tandem method the breeder selects for one character or trait at a time until that character or trait is improved, then selects for a second, etc., until each has been improved to the desirable level. The total-score method is selecting for all characters simultaneously by using an index of net merit, based on the degree to which the individual is inferior or superior in each of numerous desirable factors. In the third, or independent-culling, method, definite culling levels are established for each character and all individuals below that level are culled or discarded, regardless of the superiority or inferiority of their other characters.

The most effective method is selecting for all characters simultaneously, or for a total score; the least effective is the tandem method, or selecting for one character at a time.

Iowa State College investigators have made a theoretical comparison of selecting by each of these three methods. They found that selecting for a total score based on any number (N) of equally important, unrelated traits to be equivalent to the square root of that number ($\sqrt{N}$) times as efficient as selecting for one trait at a time. However, the progress made in any one trait by the total-score method is only $\frac{1}{\sqrt{N}}$ times as much as if selection were directed at that trait alone. For example, if 16 equally important unrelated traits are selected for simultaneously, 4 times as much progress would be made as in selecting for 1 trait at a time. Only one-fourth as much progress would be made for each trait as would be made for 1 of the 16 traits if selection were directed to it alone.

The method of independent culling to definite levels is approximately intermediate in efficiency between the other two. Progress by each method, of course, depends upon the degree of selection. The method of independent culling levels has one practical advantage over the total-score method in that birds may be culled for each trait whenever that trait becomes evident, without waiting until all traits can be measured. If independent culling levels are established for several traits, culling too drastically for one trait limits the amount of selection which can be practiced for others. A culling level set too high for a trait which is low in heritability or of small economic importance automatically lowers the intensity of selection for other traits.

CHARACTERS OF SPECIAL ECONOMIC IMPORTANCE

Poultry breeders in general have followed the practice of selecting more or less to a total score. It is a very common practice, for example, for the egg-production record to be used as an index or total

score of the 5 genetic hereditary characters contributing to the total egg production for the year. Table 1 gives the total production, rate of production, persistency, maturity, and remarks indicating the occurrence of one or more pauses or broodiness for 25 Single-Comb Rhode Island Reds. It will be noted by studying this table that the egg production during the first year of lay represents all 5 genetic characters fairly satisfactorily.

TABLE 1.—*Individual egg production records as an over-all score of the 5 genetic characters contributing to annual egg production*

Pullet No.	Annual egg production	Rate of production (eggs during first 60 days)	Persistency (production period)	Maturity (age at first egg)	Remarks
	Number	*Number*	*Days*	*Days*	
1	241	41	387	208	
2	257	46	384	204	Broody.
3	233	50	395	170	Broody and paused.
4	243	48	410	185	
5	231	39	382	180	Do.
6	226	47	403	190	Broody.
7	264	47	342	207	
8	250	52	393	178	Paused.
9	254	45	364	243	
10	267	42	393	213	
11	240	45	390	167	Do.
12	256	54	378	212	Broody and paused.
13	236	48	408	169	
14	392	49	368	193	
15	263	52	393	170	Broody.
16	244	48	407	163	
17	258	54	310	192	
18	259	46	389	165	Do.
19	228	39	320	201	
20	246	48	354	197	
21	239	50	340	186	
22	239	41	430	153	
23	218	45	330	207	
24	250	51	328	184	
25	267	51	392	198	Do.
Average	252	47	376	189	

Some breeders consider each of the characters separately in order to be sure not to mate the member of one family to members of another family showing the same undesirable character. For instance, bird No. 1 might be a good bird to breed from, as her record shows persistency and no occurrence of broodiness or pause, but she should be mated to a male from a family with a high rate of production. Bird No. 2 should not be mated to a male whose dam or full sisters showed any instances of broodiness.

The data in table 1 include only the characters related to number of eggs. The characters outlined under Quality of eggs laid (page 2) are of economic importance. Egg weight has been given more attention than any other measure of egg quality. Egg number and egg weight have been selected for at the same time by U. S. Record of Performance breeders. These levels have been the U. S. R. O. P. requirements of 200 or more eggs averaging 24 or more ounces per dozen. A large number of U. S. R. O. P. breeders use in their U. S. R. O. P. matings only females that laid 250 or more eggs averaging 25 or more ounces per dozen. This is an example of a widely used practice of culling to definite levels for egg production and egg weight each of which is determined by a group of factors that are not selected to definite levels.

Figure 1 illustrates selection to definite levels (independent-culling method) of 250 or more eggs and 25 ounces or more per dozen, as compared with selection to a total score.

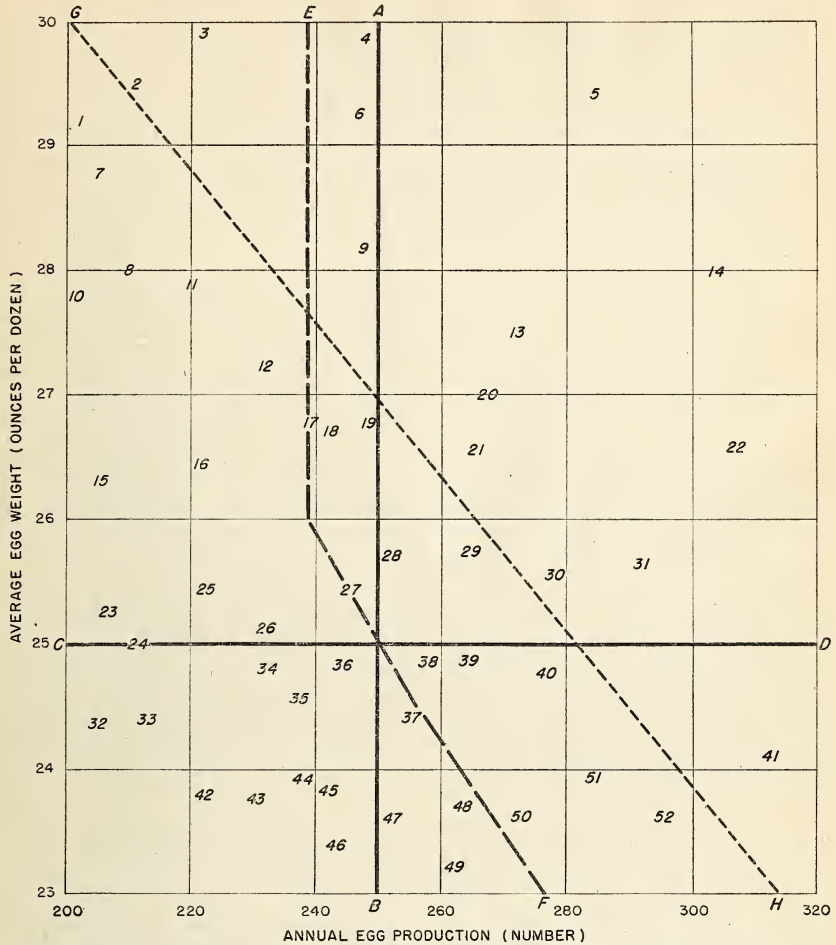

FIGURE 1.—How three methods of selection would affect birds of different characteristics. Numbers on face of chart are those assigned to birds for which trapnest records were kept. Their locations indicate number and weight of eggs laid during year.

GH, Elimination line which may be used in applying total-score or index methods.

EF, Culling level for point system.

AB and *CD*, Arbitary production and weight levels.

Under the independent-culling method, the birds to the left of the vertical line *AB* would be eliminated on egg production, and those below line *CD* would be eliminated on account of egg weight. Then only those located in the upper-right section would be used as breeders. This would mean that not one of the birds in the upper-left section or lower-right section would be used, although some of them may be more valuable than those selected.

If a total score or index is used, the line *GH* would separate those to be eliminated from those to be used as breeders. If the point system used by the official egg-laying test is used, the line *EF* represents the culling level equivalent to 250 eggs averaging 25 ounces per dozen.

Almost any total-score method would allow bird No. 41 to be used and since she laid 317 eggs averaging 24.2 ounces per dozen, usually she would be used regardless of any established culling limit for egg size. Birds No. 51 and No. 52 did not qualify for egg weight and, therefore, could be used only in trial matings. Birds No. 4 and No. 6 each laid 247 eggs, averaging more than 29 ounces per dozen. Their total points were satisfactory, even when the maximum level of points for egg size is 26 ounces per dozen. Their egg size probably would be considered too high for developing uniform egg size.

When more factors are added to egg numbers and size, it becomes even more difficult to construct an index that will give maximum accuracy in selection. As previously stated, the relative economic values and the heritability of the different traits vary greatly. The economic importance of some traits changes from year to year. Some traits are so simple in their inheritance that they can be permanently fixed in the strain in a very short time. The sex-linked recessive character for rapid feathering is an example. It is of great economic importance in broiler production and may be fixed in a relatively short period of time. To illustrate, if all the birds used for breeders had tail feathers at 10 days of age, all their progeny will have tail feathers at the same age and will breed true for that character.

Rate of production and persistency are examples of two characters that are not highly heritable but are of great economic importance since they contribute so largely to the number of eggs laid. The weight, therefore, that should be given each trait is in proportion to its economic value times its heritability. Characters like egg production and livability that are low in heritability but of great economic importance should be selected for on the basis of family tests, including both sib and progeny tests.

CLASSIFICATION ON BASIS OF ALL CHARACTERS

The most practical method for the poultry breeder to follow for maximum progress in selection would be to use a total score based on a few simple grades and then classify each dam according to these grades at definite periods of selection. Suggested grades are A, B, and C; or excellent, satisfactory, and poor. The factors considered could be designated by small letters and if the bird is poor for one or more of them, these letters could follow the large letter; e. g., B ^{ab} meaning satisfactory breeder on a total-score basis but poor for factors a and b.

Some such system as the following is suggested:

I. Grade made prior to hatching season (reasons for grade indicated by small letter).

a. Family size (at least 8 full sisters).
b. Family production.
c. Family egg quality.
d. Family livability.

e. Family physical characters.
f. Hen's individual record for rate.
g. Hen's individual record for persistency.
h. Hen's individual record for broodiness.
i. Hen's individual record for pauses.
j. Hen's individual record for sexual maturity.
k. Hen's progeny record for production.
l. Hen's progeny record for livability.
m. Hen's progeny record for egg quality.
n. Hen's progeny record for physical characteristics.

II. Grade made on the basis of progeny test prior to time pullets are selected as U. S. R. O. P. candidates.

a. Fertility.
b. Hatchability.
c. Livability of chicks.
d. Rate of growth.
e. Rate of feathering.
f. Fleshing at a given age.
g. Physical characters.
h. Number of daughters.

The method would be more effective if the breeder would also grade his hens in U. S. R. O. P. matings during the middle of the hatching season. Grading at this period enables him to save chicks from the best dams during the latter part of the hatching season and to cull his early hatched cockerels.

In a practical breeding program, selection often must be made for each character or group of characters soon after they are observed in the progeny. One score should be available when decision is to be made on the families to be trap-nested, another when the cockerels are to be selected to head the breeding pens, and another to determine the dams from which all pullet chicks are to be saved. Since culling to a definite level may be practiced at the time each trait can be observed, it may be desirable to use this method in combination with the total-score method.

Family size, a composite measure of second-year production, fertility, hatchability, and livability, may be scored soon after a few hatches are obtained. After this character is adequately measured, progeny may be saved only from the sires and dams having a high score. Adequate family size is also very necessary in order to obtain a reliable measure of other characters, such as rate of growth, rate of feathering, laying-house performance, and livability.

After adequate observations have been made for growth, feathering, fleshing conditions, defects, and other characters, this information may be added to the score for family size. Then the daughters should be entered as candidates for U. S. R. O. P., and only the sons from the families with a satisfactory total score saved for breeders. At this time, no information will be available on laying-house performance, but the progeny from the high-scoring families are just as likely to lay and live as well as, if not better than, those from low-scoring families. The larger family size in the high-scoring families will also provide a more reliable family measure of laying-house performance.

Prior to the next breeding season, the laying-house performance should be added to the total score or scored separately and considered along with the first score. Information may be obtained on sexual maturity, rate of production, and egg quality for the progeny of each sire and dam that is available to be used another year and for the full sisters of the cockerels used in U. S. R. O. P. matings.

After all the daughters have completed the trap-nest-record year, the score can be completed by including information regarding broodiness, pause, persistency, and livability. Although the sires are at least 2½ and the dams at least 3½ years of age by this time, this information is very valuable in selecting the progeny to be used in U. S. R. O. P. matings for the following season. Since complete information is available on the full sisters of the qualifying females, they may be selected on a family basis. Some of the brothers of the qualifying hens may be available to head U. S. R. O. P. matings, especially if their sires and dams were remated the second year.

The best known over-all measure of laying-house performance on a family basis is a hen-housed [1] production average for the family. This gives an accurate total score on livability and egg production, provided culling is kept to a minimum. If some of the daughters are culled for broodiness, lack of persistency, egg size, egg shape, or other characters, the hen-housed average will obviously be lowered.

[1] Obtained by dividing the number of eggs laid during the year by the number of birds entered.

THE THREE METHODS OF SELECTION IN BRIEF

Selection of poultry breeding stock for a number of characters at one time on the basis of a total score is much more progressive than selecting for one character at a time.

Selecting for a number of characters at one time on the basis of independent-culling levels for each character is more efficient than selecting for one character at a time, but is less efficient than culling on the basis of total score. Selection to independent culling levels, however, permits earlier culling because selection can be made for each character at the time the birds are handled on the range.

In selecting on the basis of a total score, the characters should be weighed in accordance with their economic importance and their heritability.

It would be practicable for the breeder to grade each breeding bird into one of three classes; for example, excellent, satisfactory, and poor, on the basis of all the characters that can be observed or measured at each of several selection periods.

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